NuMI Beam Monitoring System Review Comments
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I. GENERAL
   A. Although crucial design issues have been thoroughly investigated and finalized for internal chamber pad design, several external design issues seem to still be in flux or in need of refinement.
   B. The attention paid to proper materials (rad hardness, outgassing, interaction with particle flux) appears to be appropriate for the situation. It is refreshing to see that most of the materials have been tested in operating environments. Results from the ceramic putty test should be looked at carefully before this untried material is applied to the hadron monitor.
   C. A great deal more thinking is required for the removal/installation procedure of a radioactive hadron monitor. This planning is necessary before detailed engineering of installation equipment and the storage coffin can be performed. It is recommended that the finalized procedure and equipment undergo a separate mini-review.
   D. Support structures for both monitors seem to have overly complicated or un-needed features. It is suggested that they be revisited at the conceptual level (see individual comments below) in order to simplify construction, enhance function, and reduce cost.

II. MUON MONITOR
   A. The chamber design seems to be well thought out and functional. Although it would be nice to get the number of welds on the feedthrough flange reduced by coupling the HV leads in some manner.
   B. The 1 mm tolerance allowance seems a little tight for the stack-up of bolted connections. Also, the long lever effect may make it difficult to get the internal C channel to mate properly with the features on the box tubing (an error of .006" on the welded tabs connection (on the feedthrough plate) would eat up the entire 1 mm allowance at the bottom clamp feature (on the box tubing)).
   C. The PEEK caps have to provide compression to the HV plane. Perhaps a separate nut for those locations (as Sasha suggested) would be useful to ensure that the PEEK threads do not creep or loosen with time.
   D. For self-locking screw threads, look into using Spiralok taps and/or nuts. We have used these with good success at the AP-0 Target Hall to prevent threaded connections from loosening.
   E. The support structure has me a bit baffled. Although I like the three point base support, the way the load is transferred (through a rectangular structure) to those three points is akward and complicated. I would recommend a triangular base structure with a single central diagonal brace be investigated. This would eliminate the need for separate diagonal struts and save on weight.
   F. The connections of the three frame structures to each other are overly complicated. Instead of welding flat plates at precise angles to achieve the

proper orientation, perhaps the connections could be pinned (like truss construction).

G. The back nuts on the rear kinematic mount look to be inaccessible from the drawings we were shown.

H. If the weights of the frame pieces are truly around 140 pounds, transport and assembly could be a real chore. Do-able but not at all pleasant. The design changes suggested above should help to lower weight and allow for easier assembly.

I. The necessity for a survey in the alcoves whenever a chamber is replaced seems cumbersome. Perhaps the adapter plates on the chamber endflanges could be designed to allow for the chambers to be 'pre-aligned' with respect to the tooling balls on the chambers so that this survey task in the alcove could be eliminated.

II. HADRON MONITOR

A. I agree that the bulkhead feedthrough method of attaching the feedthroughs to the back plate is preferable to welding (avoids warping).

B. An acceptable total leak rate for the monitor should be determined to aid in leakchecking/sealing of the numerous feedthroughs.

C. The use of a belleville washer (spring washer) to ensure compression on the gasket (J. Hylen's suggestion) is a good one as long as thread locking is also ensured. In otherwords, the addition of a 'soft' spring means that the load on the nut threads may be lower than what is necessary to achieve a good lock. Using a backing nut (jam nut) or spiralok nuts may help to ensure the nut does not back off due to vibration or thermal cycling.

D. The front 'cover' foil (.010" thick) is quite delicate and could easily be damaged during handling or by inadvertant overpressure. Considerations to make it thicker should be entertained.

E. Inadvertant overpressure of the monitor should be investigated and proper controls instituted (what if analysis). Some scenarios to consider are blockage of exit tubing, failure of pressure regulator, and operator error.

F. A more detailed thermal analysis should be conducted that takes into account the spatial and time concentration effects rather than uniform, average heating. Although the heating rates seem to be low, it should not take much effort to calculate a maximum thermal gradient that could be expected across the width of the back plate and/or the cover foil.

G. I assume thermal effects on the ionization 'pads' themselves were tested when the 'pads' were tested in the Booster without any ill effects noted. If not, a quick thermal analysis of a central pad should be done for comfort sake.

H. The entire monitor removal and re-installation procedure needs to have some serious thought put into it. The finalized procedure will have impact on the design of the support rails, the lifting fixtures and devices, and the design of the coffin. Several ideas were put forward at the review. The hadron monitor design team should take those ideas, add their own, and come up with a reviewable game plan. A few observations:

1. Tag lines or control lines should be used to help guide the monitor assembly when it is free-hanging from a hoist.

2. If the coffin is raised to the height of the absorber, be aware that it will occlude sight of the sliding monitor.
3. Rollers are probably not needed (and may actually cause problems if they get jammed with debris). Sliding pads should be satisfactory.
4. I don't like the idea of a coffin with one thin side to save on weight, even if it is the bottom side. One never knows how the coffin might be handled in the far future (lifted by a crane or fork truck). At AP-0 we provide adequate shielding on all six sides.
5. Contamination may be a problem from rusting steel and paint flakes (a common problem in AP-0). This rust particulate may interfere with sliding and other mechanisms.
6. It is not uncommon for tasks like this to have unforeseen problems that require some close manual manipulation. This should be expected and accounted for in any dose estimations.